North South University
Department of Electrical & Computer Engineering
LAB REPORT- 02

Course Code: CSE 231

Course Title: Digital Logic

Section: 09

Lab Number: 02

Experiment Name:

Combinational Logic Design

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Group members:

Name	ID	Obtained Mark Simulation [5]	Obtained Mark Lab Report [15]
1. Shakil Ahmed	2221453042		
2. Munem Bulbul	2221314642		
3. Sudipto Roy	2222756042		
4. MD Rayhan Sharif Rafsun	2222472042		

Course Instructor: Omer Ibne Shahid (OISD)

Submitted To: Pritthika Dhar

Experiment Name: Cobinational Logic Design

Objectives : • Becoming familirize with the analysis of combinational logic network

• Learning the implementation of networks using two canonical forms.

• Devise combination circuit using universal logic

• Acquint with basic binary arithmatic circuits

Apparatus : Trainer Board, 1 × IC 7411 Tripple 3-input AND gates, 2× IC 7432 Tripple 3-input OR gates. 1×IC 7404 Hex Inverters

Theory : Minterm for each combination of the variables that produce a 1 in the function and taking the 'OR' of all those terms.

• minterm in variables = product of n literals in which each variable appears exactly once either in T or F form.

• Each minterm has value 1 for exactly one combination values of variables. example: $ABC (111) \Rightarrow m7$.

• A function can be written as a sum of minterms, refferred to as a minterm expansion or a standard sum of products.

Maxtem for each combination of variables that produces a 0 in the function and then taking the AND of all those terms

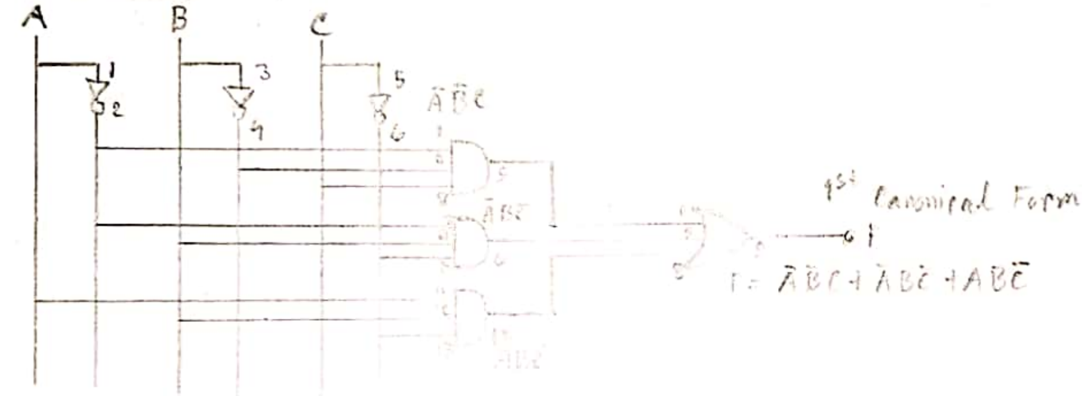
• maxterm of n variables = sum of n literals in which each variable appears exactly one in T or F form, but not in both

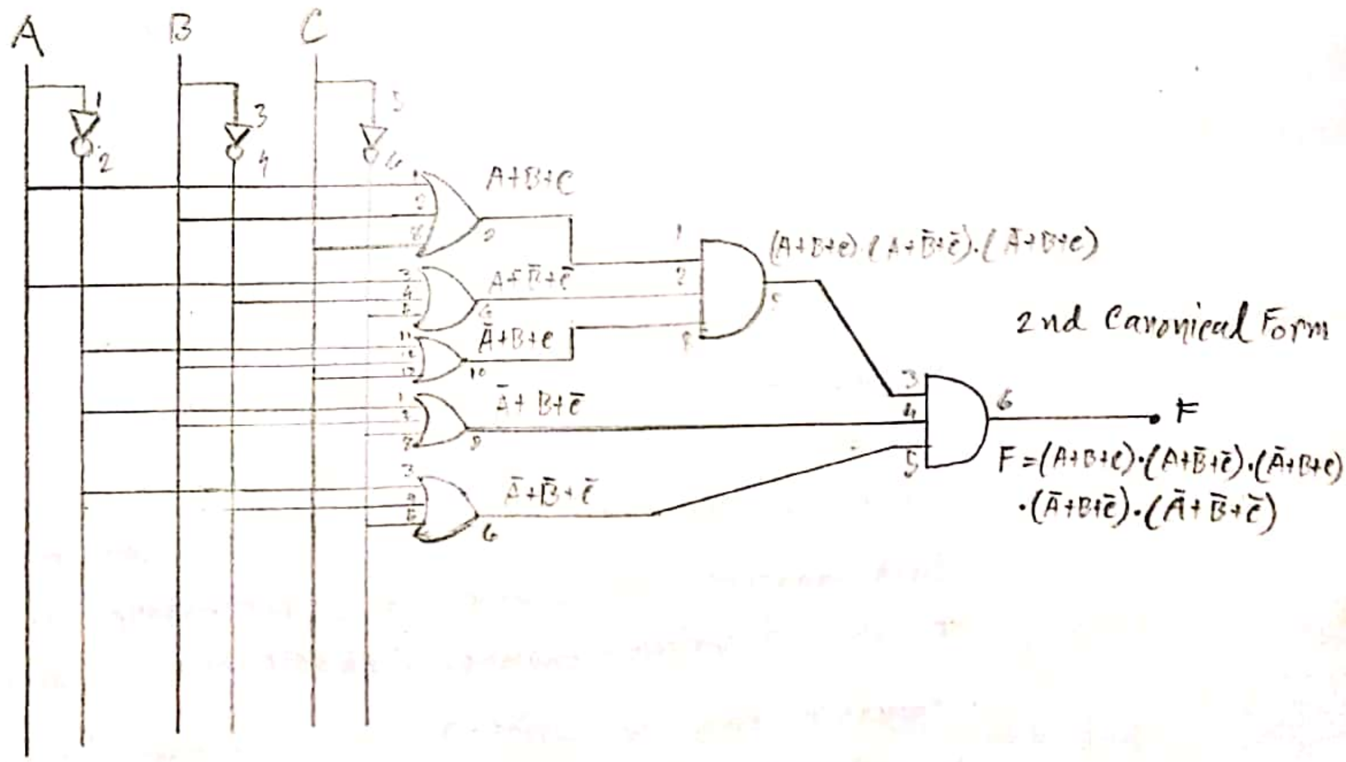
• Each maxterm has a value of 0 for exactly one combination of values of variables. example: $A+B+C' (001) \Rightarrow M_1$ (value is 0)

• Function can be written as a product of maxterms, which is referred to as a maxterm expansion or standard product of sum

Canonical forms: The technique that is used to represent the mathematical entities or matrix in it's standard form is termed as canonical form. The term canonicalization is also known as standardization or normalization with respect to the equivalence relation.

Circuit Diagram:





Experimental Procedure: All the minterms of three inputs ABC:
$\bar{A}\bar{B}\bar{C}(m_0)$, $\bar{A}\bar{B}C(m_1)$, $\bar{A}B\bar{C}(m_2)$, $\bar{A}BC(m_3)$, $A\bar{B}\bar{C}(m_4)$, $A\bar{B}C(m_5)$, $AB\bar{C}(m_6)$, $ABC(m_7)$.

All the Max terms for three input ABC:

$A+B+C(M_0)$, $A+B+\bar{C}(M_1)$, $A+\bar{B}+C(M_2)$, $A+\bar{B}+\bar{C}(M_3)$, $\bar{A}+B+C(M_4)$, $\bar{A}+B+\bar{C}(M_5)$, $\bar{A}+\bar{B}+C(M_6)$, $\bar{A}+\bar{B}+\bar{C}(M_7)$

In the logic/Trainer board we will set up the connections like for for 1st canonical form minterms will be m_1, m_2, m_6 which will give us 1 output. And for 2nd canonical form ~~M_7, M_2 and M_3~~ M_0, M_3, M_4, M_5 and M_7 will give us True output.

Experimental Data Table:

Input Reference	A B C	F	Minterm		Max term	
0	0 0 0	0	$\bar{A}\bar{B}\bar{C}$	(m_0)	$A+B+C$	(M_0)
1	0 0 1	1	$\bar{A}\bar{B}C$	(m_1)	$A+B+\bar{C}$	(M_1)
2	0 1 0	1	$\bar{A}B\bar{C}$	(m_2)	$A+\bar{B}+C$	(M_2)
3	0 1 1	0	$\bar{A}BC$	(m_3)	$A+\bar{B}+\bar{C}$	(M_3)
4	1 0 0	0	$A\bar{B}\bar{C}$	(m_4)	$\bar{A}+B+C$	(M_4)
5	1 0 1	0	$A\bar{B}C$	(m_5)	$\bar{A}+B+\bar{C}$	(M_5)
6	1 1 0	1	$AB\bar{C}$	(m_6)	$\bar{A}+\bar{B}+C$	(M_6)
7	1 1 1	0	ABC	(m_7)	$\bar{A}+\bar{B}+\bar{C}$	(M_7)

Truth table to a combinational circuit

	Shorthand Notation	Function
1st Canonical Form	$F=\Sigma(m_1, m_2, m_6)$	$F=\bar{A}\bar{B}C+\bar{A}B\bar{C}+AB\bar{C}$
2nd Canonical Form	$F=\Pi(M_0, M_3, M_4, M_5, M_7)$	$F=(A+B+C)\cdot(A+\bar{B}+\bar{C})(\bar{A}+B+C)(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+\bar{C})$

1st and 2nd canonical forms of the combinational Circuit

Discussion: In this experiment we learned abot the two canonical forms and how they work. We also learned that two differen circuit can give same result if arranged properly For this experiment we had 1 IC ~~74~~04 Hex Inverter (Notgat 1 IC with three input AND gate ~~74~~ 4073 and two IC with three input OR gate 4075. For minterm we didnt face any problem as it only required one AND and one OR and a Hex Inverter. But in Maxterm we had to use two OR IC gate and the circuit was very complex for that reason it took more time than expected.

While using two OR gates we used 1 OR IC tom three Maxterm then connected output to AND gate input while the two other OR output from the other OR IC we connected these inputs to second AND input and got the expected output.

Wiring the circuit in maxterm was quite challenging because we needed to connect a lot of gates. We also needed to use a lot of wires. and Alhamdulillah the the experiment was working out. All our equipment were working perfectly. We did it on first try and did not face that much trouble in this experiment.

North South University
Department of Electrical and Computer Engineering
CSE 231L: Digital Logic Design Lab
Lab 02: Combinational Logic Design

A. Objectives

- Familiarize with the analysis of combinational logic network.
- Learn the implementation of networks using the two canonical forms.
- Devise combinational circuits using universal logic.
- Acquaint with basic binary arithmetic circuits –the half and full adders.

B. Theory

Concise theory pertinent to lab experiments to go here to aid students in performing experiments with minimal supervision. For example, topics for this lab should include definition and steps to:
Analysis of combinational logic design Min terms and max terms
Canonical Forms
Universal gates – bubble pushing, De Morgan's theorem.

C. Experiment 1: Analysis of a Combinational Logic Circuit

C.1. Equipments:

- Trainer Board
- 1 x IC 7411 Triple 3-input AND gates
- 1 x IC 7432 Quadruple 2-input OR gates
- 1 x IC 7404 Hex Inverters (NOT gates)

C.2. Procedure

Input Reference	$A\ B\ C$	F	Min term	Max term
0	0 0 0	0	[illegible]	$A+B+C$ (M_0)
1	0 0 1	1	[illegible]	$A+B+\bar{C}$ (M_1)
2	0 1 0	1	$\bar{A}B\bar{C}$ (m_2)	$A+\bar{B}+C$ (M_2)
3	0 1 1	0	$\bar{A}BC$ (m_3)	$A+\bar{B}+\bar{C}$ (M_3)
4	1 0 0	0	$A\bar{B}\bar{C}$ (m_4)	$\bar{A}+B+C$ (M_4)
5	1 0 1	0	$A\bar{B}C$ (m_5)	$\bar{A}+B+\bar{C}$ (M_5)
6	1 1 0	1	$AB\bar{C}$ (m_6)	$\bar{A}+B+C$ (M_6)
7	1 1 1	0	ABC (m_7)	$\bar{A}+\bar{B}+\bar{C}$ (M_7)

Table C.1 Truth table to a combinational circuit

1. Write down all the min terms and max terms of three inputs ABC in Table C.1.
2. Write down the function F in 1st and 2nd Canonical Forms in Table C.2.

	Shorthand Notation	Function
1st Canonical Form	$F=\Sigma(m_1, m_2, m_6)$	$F=\bar{A}\bar{B}C+\bar{A}B\bar{C}+AB\bar{C}$
2nd Canonical Form	$F=\Pi(M_0, M_3, M_4, M_5, M_7)$	$F=(A+B+C)\cdot(A+\bar{B}+\bar{C})\cdot(\bar{A}+B+C)\cdot(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+\bar{C})$

Table C.2 1st and 2nd canonical forms of the combinational circuit of Table C.1

3. Draw the circuits in the space provided below, clearly indicating the pin numbers corresponding to the relevant

ICs.

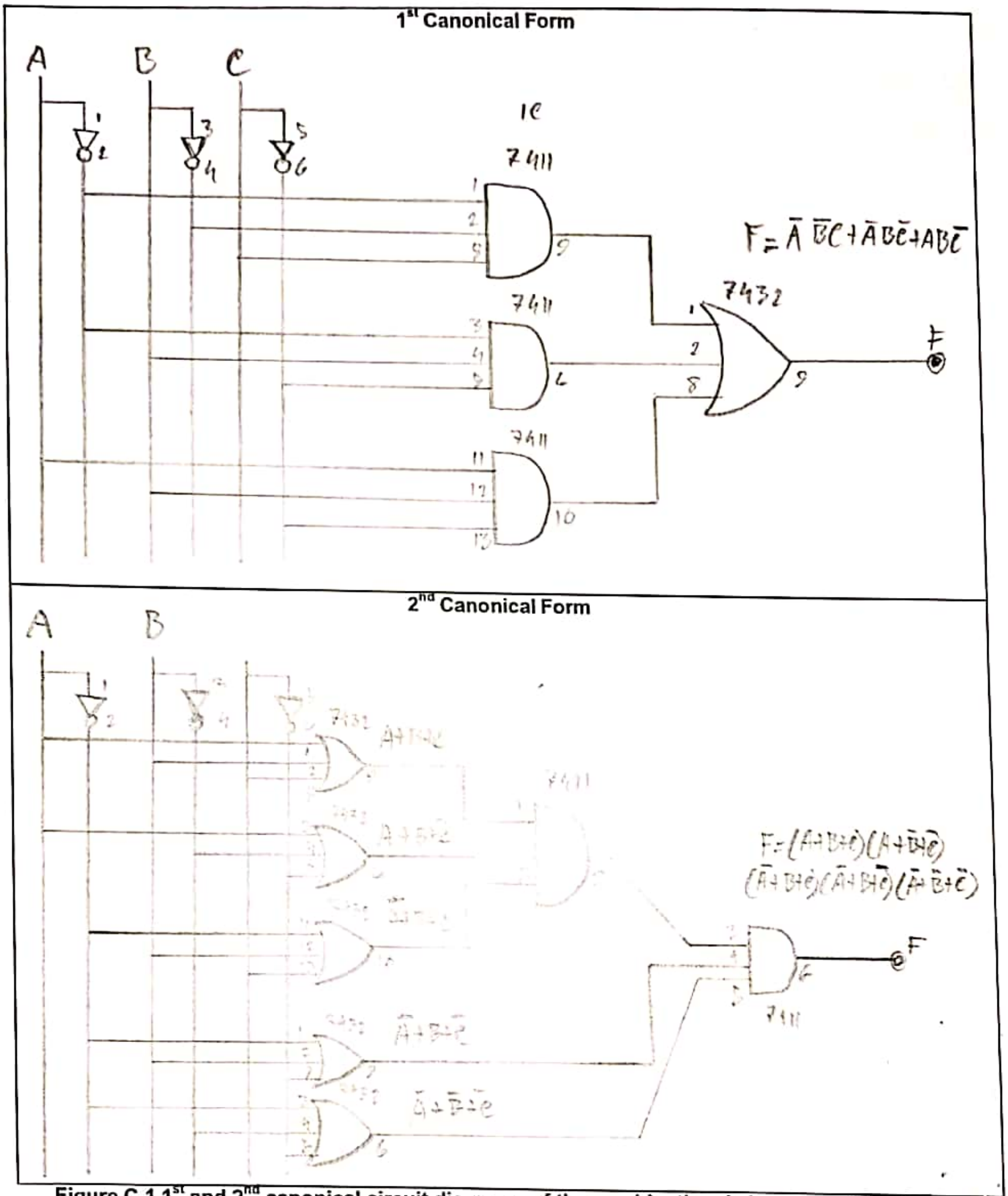


Figure C.1 1st and 2nd canonical circuit diagrams of the combinational circuit of Table C.1

4. Construct the 1st canonical form of the circuit and test it with the truth table.
   i. Connect one min term at a time and check its output.
   ii. Once all min terms have been connected and verified, OR the min terms for the function output.

C.3. Report

Simulate above two circuits (1st and 2nd canonical forms) in Logisim.

Pritthika
13/3/24